



INVESTOR IN PEOPLE

The Patent Office  
Concept House  
Cardiff Road  
Newport  
South Wales  
NP10 8QQ

REC'D 16 DEC 2003

WIPO

PCT

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 12 November 2003

**BEST AVAILABLE COPY**

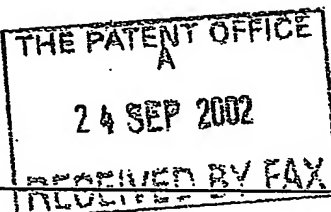
**PRIORITY  
DOCUMENT**  
SUBMITTED OR TRANSMITTED IN  
COMPLIANCE WITH RULE 17.1(a) OR (b)

## Patents Form 1/77

Patents Act 1977.  
(Rule 16)24SEP02 E75 19-1 00924  
P01/7700 0:00-0222137.2

## Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form.)



The Patent Office

Cardiff Road  
Newport  
South Wales  
NP10 8QQ

## 1. Your reference

02445 GB

## 2. Patent application number

(The Patent Office will fill in this part)

24 SEP 2002

0222137.2

3. Full name, address and postcode of the or of each applicant (underline all surnames)

08470551001

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

Invensys Controls UK Limited  
Invensys House  
Carlisle Place  
London  
SW1P 1BX

United Kingdom

## 4. Title of the invention

Diagnostic Tool for an Energy Conversion Appliance

## 5. Name of your agent (if you have one)

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Mr J R Badger  
Invensys Intellectual Property  
P O Box 8433  
Redditch, B98 0DW  
United Kingdom

Patents ADP number (if you know it)

07824766001

## 6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
(if you know it)Date of filing  
(day / month / year)

## 7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
(day / month / year)

## 8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

YES

- a) any applicant named in part 3 is not an inventor, or  
b) there is an inventor who is not named as an applicant, or  
c) any named applicant is a corporate body.  
See note (d))

Patents Form 1/77

BEST AVAILABLE COPY

0048906 24-Sep-02 04:49

## Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	4
Claim(s)	0
Abstract	0
Drawing(s)	2

10. If you are also filing any of the following, state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	0
Request for preliminary examination and search (Patents Form 9/77)	0
Request for substantive examination (Patents Form 10/77)	0
Any other documents (please specify)	0

11.

I/We request the grant of a patent on the basis of this application.

Signature

Date

N. R. Badger 24/9/02

12. Name and daytime telephone number of person to contact in the United Kingdom

J R Badger

01527 838264

## Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

## Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.

Patents Form 1/77

## DIAGNOSTIC TOOL FOR AN ENERGY CONVERSION APPLIANCE

The present invention relates to a diagnostic tool for an energy conversion appliance and particularly but not exclusively to an appliance which utilises more than one form of energy and / or medium. The diagnostic tool may for example be used with heating, ventilating and air conditioning appliances.

Increasingly, diagnostic tools are being embedded into control systems of appliances. Not only does this allow service engineers to rapidly diagnose faults, but, with the rapid increase of connectivity technology, diagnostic data can be sent via telephone or other communication channels to "back-end" systems where sophisticated diagnostic and predictive algorithms can be run.

The advantage of a pre-diagnostic tool to the Service provider is that fault repair can be accomplished in one visit to the customer's premises, while the predictive nature of the system means that preventative maintenance can be applied during annual service visits.

The advantage to the Customer is reduced system problems and very rapid repair of faults.

Currently these systems are mainly applied to new appliances, which means that it will be many years before the installed population of these devices reaches a level to make economic sense to the service provider.

This invention may be applied to, heating and air conditioning appliances employing combustion processes for the heating source. In this case the description relates to a device to be used in a domestic central heating boiler.

In these types of system the sequence of the control functions is critical to the safe operation of the appliance. Many of the international regulations for these types of appliances dictate the correct operating sequence that must apply.

Thus monitoring this sequence and detecting variations in and interruptions to the sequence provides significant diagnostic data.

To duplicate the data available to an embedded diagnostic tool with a retrofit tool would mean obtaining access to the control and sensor signals within the appliance control system. The intrusive nature of this activity could well compromise the integrity of the control or, at least, be very time consuming in installation.

The invention described is thus particularly suitable for a retrofit diagnostic tool that can be easily installed into an existing appliance, which extracts different data from, but provides the same, if not improved, functionality as an embedded system. A key feature of this invention is that it is minimally intrusive into the appliance control system and thus very simple to install.

The invention uses a microphonic sensor coupled to a sound recognition engine to identify, discriminate and log the acoustic signatures of events within the operating sequence of an appliance.

An event is defined as a change of state of a component, or components, of the operating or control system of the appliance. As an example FIG 1 tabulates a typical event sequence of a simple domestic gas central heating boiler.

Typically, the sound recognition engine could be an adaptation of a type of voice recognition system. These systems, commonly found in mobile

telephones and other applications requiring voice tagging or control, are very robust in the presence of background noise and the technology is becoming well known and reliable.

Typically, the tool will record the event sequence when the boiler is known to be operating correctly and efficiently, for example immediately following a service, and use this pattern, for reference, for comparison with subsequent measurements. Subsequent recordings of the data can be collected in memory, preferably non volatile, and used, by the tool, to extract diagnostic information, or be made available, as a data stream, on a regular basis, to transmit over a communication channel to a local, or remote monitoring device e.g. a computational system.

Further, the tool will monitor certain individual or combinations of, elements of the system where variations in the acoustic signature, with time, will provide significant diagnostic data. An example would be monitoring of the flame to detect, for example, blockage conditions in the gas valve or monitoring of the fan to detect, for example, fouling of an impeller.

Further, the tool can be used, in the event of a failure, to analyse the failure mode by reference to where in the sequence of events the failure occurred and extract significant diagnostic information even to component level

Referring to FIG 2, the invention comprises:

A microphonic sensor (1) coupled to a sound recognition engine (2). The recognition system (2) is tuned and programmed to identify individual events within an appliance operating sequence by recognising the acoustic signature of that event.

This acoustic sensor system can be used alone, or in conjunction with other sensors to obtain diagnostic information about the appliance.

A non-volatile memory (3) for storage of the processed data.

A processing unit (4) to process the data from the recognition engine (2) to organise and store, in the memory, the data into a sequence of events with respect to time; to recognise a failure of the appliance and analyse the diagnostic information associated with where in the sequence the failure occurred, initiate an alarm sequence and transmit an immediate alarm message; to monitor the acoustic signature of individual elements of components of the system and record variations in these signatures as diagnostic data or a measure of efficiency and to initiate and control the transmission of data to an external system.

A communication channel (5) to enable communication of the diagnostic data to a local or remote computational system on an immediate or regular basis.

In accordance with the present diagnostic tool a single microphonic sensor may be employed to receive acoustic signals from more than one source or type of source.

1/2

Boiler Type	Typical		
Condition	Normal Operation	Sequence A	
Event Number	Event	Time	Comment
0			External Thermostats supply power
1	Power on	0	there is no permanent live on this boiler
2	Water flows	0	
3	Relay B operates	1	
4	Relay A operates	2	assumes PS ok, Boiler stat calls.
5	Fan Runs	2	
6	Air pressure switch operates	3	
7	Gas valve 1 operates	3	Pilot valve solenoid
8	Intermittent spark	4	
9	Pilot established	5	
10	Relay B de-energises	6	
11	Spark stops	6	
12	Gas valve 2 operates	6	Main gas valve solenoid
13	Main burner cross lights	7	
			Delay until boiler thermostat satisfied
14	Relay A de-energises	8	
15	Gas valve 1 De-energises	8	
16	Gas valve 2 De-energises	8	
17	Flames extinguished	8	
18	Fan stops	8	
19	Air pressure switch releases	9	
20	Relay B operates	10	
			Delay until Boiler thermostat calls
21	Boiler temperature sensor calls	11	
22	Power off	12	External thermostats satisfied.
23	Flames extinguished	13	
24	water flow stops	14	
25	Fan stops	15	
26	Relay A de-energises	16	
27	Air pressure switch releases	17	

Fig 1



2/2

